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Nexus Nirvana or Nexus Nullity? A dynamic approach to security and sustainability in the water-energy-food nexus

Jeremy Allouche, Carl Middleton and Dipak Gyawali

Water and the Nexus

STEPS centre

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Over the last several years, the water-energy-food (WEF) nexus has emerged as an increasingly prominent global policy, governance and research agenda. Water, energy, and food security are often framed to be within a contested trade-off relationship between actors, and this framing has been reinforced by a 'scarcity crisis' narrative put forward by a number of influential global policy actors promoting the WEF nexus. In this working paper, we argue that the governance of water, energy and food security - historically concerned with safety and certainty from contingency - has privileged control-orientated solutions, in particular the construction of large dams for water storage, in the belief they are more secure and more sustainable. We critically explore the associated risks and uncertainties of this pathway, and highlight that WEF systems are by nature complex and dynamic. Furthermore, recognizing the power inequalities that often close down the consideration of alternative development pathways, we make legible the multiple framings of water, energy and food security between actors and how these are shaping policy objectives and project outcomes. Responding to the emerging WEF nexus discourse, we seek to introduce a more dynamic perspective to water, energy and food security, and argue that a shift in governance is required towards also incorporating solutions where the limits to control are acknowledged. We propose that plural water storage systems that accommodate a variety of large- and small-scale solutions are an appropriate response to such conditions of complexity and uncertainty and if social justice is to be incorporated within the WEF nexus.

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STEPS Working Paper 63

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Acronyms

ANZSEE	Australia New Zealand Society for Ecological Economics
AusAID	Australian Agency for International Development (AusAID
CPWF	Challenge Program on Water and Food
DfID	Department for International Development
DST	Desakota Study Team
ESCR	Economic and Social Research Council
ESPA	Ecosystem Services and Poverty Alleviation
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
ICOLD	International Commission on Large Dams
IFI	International Financial Institutions
IFPRI	International Food Policy Research Institute
IPCC	Intergovernmental Panel on Climate Change
ISET	Institute for Social and Environmental Transition
ISNET-N	Institute for Social and Environmental Transition,Nepal
IWRM	Integrated Water Resources Management
NCVST	Nepal Climate Vulnerability Study Team
NERC	Program of Natural Resources Environmental Council
NSS	National Security Strategy
ORG	Oxford Research Group
PwC	PricewaterhouseCoopers
SAWAS	South Asian Water Studies
STEPS	Social Technological and Environmental Pathways to Sustainability
UN	United Nations
US	United States of America
WCD	World Commission on Dams
WWF	World Wide Fund for Nature

1. Introduction

The world of development thinkers and practitioners is abuzz with a new lexicon: the idea of 'the nexus' between water, energy and food. The various global crises since 2008 in energy, food and global finance, in addition to the uncertainties brought about by climate change, have highlighted the entwined relationship between these systems, together with their relationship to water security. These crises have also revealed the limits of existing top-down institutional approaches that have hitherto sought to manage these resources to compartmentalise them into individual silos. The idea of 'the nexus' has been put forward by a range of proponents – each with their own perspectives and agendas – as a new framing of these interdependent problems, demanding new and innovative solutions.

Our goal in this working paper is to develop the conceptual tools for a project that ultimately aims to contribute towards unpacking existing formulations of the water-energy-food nexus, and rethinking some of its key tenets. We propose a dynamic approach to understanding the water-energy-food nexus. We take as our starting point the dynamic sustainability methodology (Leach *et al*, 2010) and the concept of plural water storage systems (McCartney and Smakhtin 2010) that proposes a continuum of water storage solutions – large and small – as a relational system. Framing problems in policy processes leads to particular solutions, whilst discounting alternatives, and with an emphasis on understanding this we focus, in particular, on how water, energy and food security is understood and represented by different actors, and its implications for the water-energy-food nexus, and environmental and social justice. Given that water-energy-food nexus problems are so-called 'wicked' problems with no easy definition nor easy solution, we propose that 'clumsy solutions' that benefit from the deliberate interaction of multiple worldviews on perceptions of problems are an appropriate approach to solving such real world problems (Verweij *et al*, 2006; Gyawali 2009). This working paper thus lays the foundation for our ongoing research in South and Southeast Asia on water-energy-food nexus challenges.

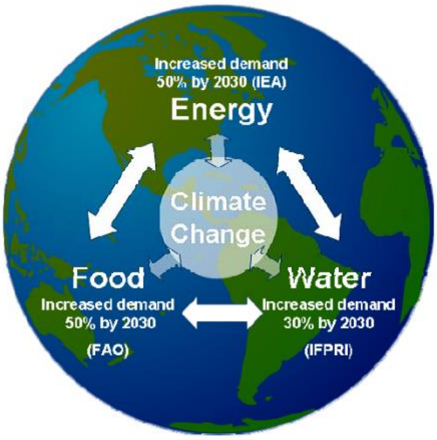
In the working paper we argue that the current global policy-framing of the nexus around a scarcity crisis narrative is driving proposed solutions towards a paradigm of control (i.e. stability and durability solutions) in which there is a much higher perception of certainty in understanding the water-energy-food systems than is actually warranted. This has thus favoured the construction of (large) man-made structures in the belief they are more secure and more sustainable. We argue that water-energy-food systems are by nature complex and dynamic systems, and even more so under the conditions of climate change. Thus to accommodate complexity and (climate) uncertainty, a shift in governance is required away from this control-orientated perspective and towards approaches where limits to control are acknowledged and incorporated (i.e. resilience and robustness solutions). We propose that plural water-storage systems, that accommodate varieties of large and small-scale solutions, are an appropriate response to such conditions of complexity and uncertainty, and for which resilience and robustness thinking is appropriate. Such a plural framing allows us to recast the definition of the water problem and redefine the boundaries of the potential solutions. If indeed a win-win solution may exist, then plural storage systems are seen as a way to address water-climate security as well as food demands and clean energy, whilst also ensuring that social justice prevails, in a world prone to financial volatility.

This paper is divided into five main sections. First, we will unpack how the various crises in food and energy led to the formulation of the nexus. Second, we will discuss the concept of the nexus and the various actors promoting it. Third, we will see to what extent a particular framing of the nexus is promoting static solutions guided by stability and durability (a *status quo*) thinking. Fourth, we propose a conceptual framework that synthesizes dynamic sustainability, plural water storage systems, and the nexus. Finally, we map out the direction of our project on water storage solutions in the context of the water-energy-food nexus in South and South-East Asia.

2. A world in crisis: Deconstructing the current policy dynamics behind the Nexus

'A perfect storm'. These were the words of John Beddington, Chief Scientific Adviser to the British Government in 2009 when talking about the relationships between food, energy, water and the climate. After 20 years of low food commodity prices, the price shock of 2007 and 2008 brought agriculture, food production and food security sharply back into the limelight.

Figure 2.1: The Perfect Storm Scenario (Beddington 2009, Figure 7)



It is predicted that by 2030 the world will need to produce around 50 per cent more food and energy, together with 30 per cent more fresh water, whilst mitigating and adapting to climate change.

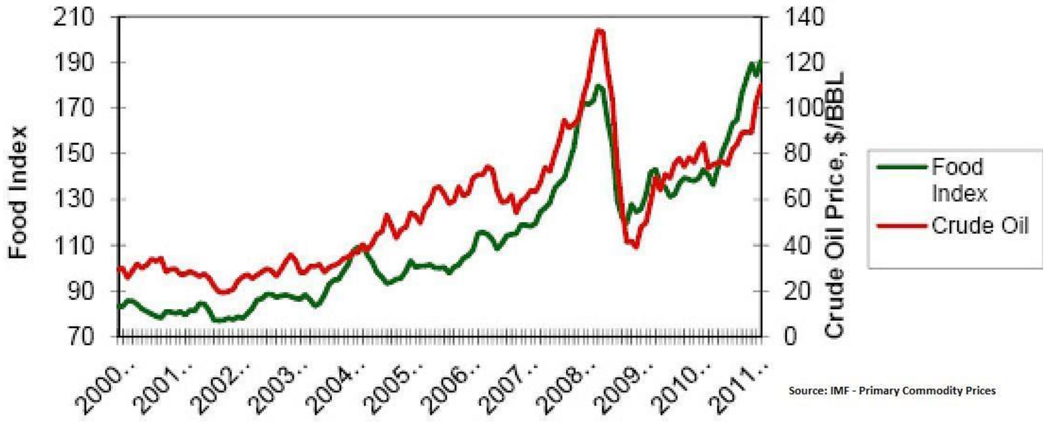
The food commodity price crisis and the ensuing food riots have brought back fears around food scarcity and food security. There are increasing concerns on the demand side, as illustrated in Figure 2.1, where global demand for food and energy is predicted to grow by 50 per cent and for freshwater by 30 per cent by 2030. The problem is that the supply side will be considerably affected by climate change. Many scientific experts have argued that water and food management will be facing major challenges. This will be due to increasing uncertainties caused by climate change and its ecological consequences, by fast changing socio-economic boundary conditions, including global redistributions of wealth and power, and changing flows of people, resources and knowledge (Hanjra and Qureshi 2010; Schmidhuber and Tubiello 2007). According to the Intergovernmental Panel on Climate Change (IPCC) predictions, as climate extremes are predicted to increase in frequency and intensity in future, droughts and floods will become more severe and more frequent (IPCC, 2007). This has an effect on global food security, as weather extremes can dramatically reduce crop yields and livestock numbers and productivity, especially in semi-arid areas. This means that some of the poorest regions, with high levels of population growth as well as chronic undernourishment, will also be exposed to the highest degree of instability in food production (Allouche 2011).

Most studies have found that climate change and other associated global environmental changes will have a highly negative impact for developing countries in terms of crop productivity, with a decrease ranging from 9 to 21 per cent by 2050 depending on the degree of change modelled (Misselhorn *et al*. 2012). However, the nature and timing of climate impacts on agriculture and their implications for human livelihoods, are clouded with many uncertainties (Hertel, *et al*, 2010). This raises important concerns about achieving food security, especially for poor people. Climate change may affect food systems in several ways ranging from direct effects on crop production, as discussed above, to changes in market volatility, food prices and supply chain infrastructure, as discussed below.

Most of the research has focused on the bio-physical aspects of production, considering factors such as land suitability, crop yields and pest regimes, hence the possible impact of climate change on food accessibility and utilization has been neglected (Schmidhuber and Tubiello 2007). Recommendations by Gregory *et al.* (2005) include reducing food system vulnerability by: (i) increasing food production (essentially through intensification and genotypes that utilize limited supplies of water stored in soils); (ii) improving food distribution (essentially through investment in infrastructure); and (iii) increasing economic access to food (essentially though food pricing mechanisms and policies, and regional specialisation). Yet while intensification is viewed as a strategy to reduce food vulnerability in the light of climate change, intensification via high-input technologies has resulted in detrimental environmental consequences, such as reduced biodiversity and water pollution in some areas. The challenge is, therefore, the need to move towards intensive systems that are both high yielding, and less resource consuming, and thus more environmentally benign.

However, these scenarios and fears around potential new food crises rely heavily on the simplistic availability assumption, namely that increased food supply will automatically reduce hunger or that the increased supply of water will improve general access to water. The crucial issue for food security, however, is not whether food is 'available' in the 'average' or 'aggregate' but whether the monetary and/or nonmonetary resources at peoples' disposal are sufficient to allow everyone *access* to adequate quantities of food. The recent food riots illustrate this point as rising prices for staple foods (i.e. maize, rice, wheat) and soybeans provoked riots in more than twenty countries, including Mexico, Morocco, Indonesia, Uzbekistan, Yemen, Guinea, Burkina Faso, Mauritania, and Senegal, and non-violent demonstrations in at least thirty more (Benson *et al*. 2008; FAO 2008; von Grebmer *et al*. 2008). These events led to the creation of a United Nations (UN) High-Level Task Force on the Global Food Security Crisis in 2008. Meanwhile, at the 2008 World Economic Forum in Davos (Switzerland), World Bank President Robert Zoellick argued that, '*...increased food prices and their threat—not only to people but also to political stability—have made it a matter of urgency to draw the attention it needs.*' Sir John Holmes, the then UN Under-Secretary-General for Humanitarian Affairs, echoed this argument. The causes of the rapid rise in food prices were heavily debated (Piesse and Thirtle 2009). The growing demand for food from rapidly developing countries (in particular China), the high price of oil, and the conversion of many crops to biofuels, all of which create pressure on the demand side, are highlighted by some analysts (Royal Society 2008). For others, weather-related poor harvests, flawed food and development policies, speculation in global financial markets and the legacy of 'food wars' were also important factors (see Messer 2009).

Figure 2.2: Food and Crude Oil prices, 2000-2011



The emergence of the new nexus policy paradigm around water, energy and food (Bazilian *et al*. 2011) was also fuelled by fears linked to the 2007 global energy crisis when oil prices increased dramatically. Figure 2.2 reveals the strong correlation between the price of crude oil and the UN Food and

Agriculture Organization's (FAO) Food Price Index. This oil crisis was demand-led, unlike previous oil shocks which were caused by sudden interruptions in exports from the Middle East. Many energy specialists at the time predicted that prices would continue to trend upwards, the reasons being the deteriorating value of the US Dollar vis-à-vis the Euro (although this trend has, for now, reversed) and also the significant growth of the Asian economies, especially China and India (Hamilton 2009). Due to the sheer size of their domestic markets and their energy consuming industries there is a strong demand for oil, which pushes the energy price index up.

These trends have long-lasting global implications. If global demand continues to rise then, correspondingly, energy production must also grow substantially each year, even as constraints imposed by social, environmental and geopolitical realities become more pronounced. According to the projections of the US Department of Energy, world energy output, based on 2007 levels, must rise 29 percent to 640 quadrillion British Thermal Units by 2025 to meet anticipated demand (quoted in Klare 2011). Furthermore, rising concerns about the long term availability and price of not only oil, but also gas and uranium, only add to the fears and perception linked to this global energy crisis, even as shale gas opens up the possibility of new sources for the fossil fuel industry.

Both the food and energy crises have fuelled a growing perception of scarcity that has inevitably been reinforced by climate change and environmental degradation narratives (e.g. Hartmann 2014). Scientific research has now claimed to have identified potential critical thresholds and tipping points in the Earth system. A range of studies from system scientists argue that human activities drive multiple, interacting effects that cascade through the Earth system. Rockstrom *et al.* (2009) state and quantify nine interacting 'planetary boundaries' with possible threshold effects that manifest themselves at the planetary level, possibly in a non-linear way. These are namely: climate impacts; ozone depletion; atmospheric aerosol loading; ocean acidification; global freshwater use; chemical pollution; land system change; biodiversity; and biogeo-chemistry. These 'planetary boundaries' are, however, not fixed. They represent estimates of just how close to an uncertainty zone around a potential threshold the global human community can operate without seriously challenging the continuation of the current state of the planet within which human settlements and cultures have flourished (Galaz *et al.* 2012). However, this implies drawing a 'safe operating space for humanity' which is bound to be a highly controversial project, as it echoes previous notions of 'limits to growth' and value judgments that are intrinsic to such estimates and the politics that ensue from them.

Overall, one can see that scarcity narratives about food and energy, together with global security concerns around environmental thresholds and financial volatility are creating new policy configurations and proposed responses to these crises. One of them has been the emergence of the water-energy-food nexus.

3. The Water Energy Food (WEF) Nexus

The idea of 'nexus' is the latest arrival in the world of resource management. As an idea that started at the World Economic Forum in 2008, it has gained relevance over time, through the Bonn Conference in 2011,[4] the Sixth World Water Forum in Marseilles, France and the Rio +20 negotiations in 2012, making it the new term to define sustainable development within this sphere of policy makers (Gies 2012). The 2014 Stockholm Water Week is also very much inspired and influenced by the nexus vocabulary.[5]

The 'nexus' debate is primarily a debate about natural resource scarcity (Dupar and Oates 2012). It is not surprising, therefore, given this perceived scarcity over food, energy and water resources and the various energy and food crises in 2007 and 2008 that the World Economic Forum first proposed the concept of the nexus.[6] The 2008 World Economic Forum recognised that water is linked to economic growth through a nexus of issues. A year later, in 2009, UN Secretary-General, Ban Ki Moon, also addressed the World Economic Forum meeting at Davos and underlined the imperative of private sector participation to deal with these crises. This growing momentum led to a proliferation of special bodies within the World Economic Forum, to deal with water issues including the creation of a Global Compact CEO Water Mandate and the Water Security Global Agenda Council. The World Economic Forum's formulation of the nexus has primarily been driven by international private actors, who see the nexus – and subsequently also the concept of Green Economy (see below) – both as an opportunity and a constraint to their business. It strongly links water security to economic growth:

> Water lies at the heart of a nexus of social, economic and political issues - agriculture, energy, cities, trade, finance, national security and human lives, rich and poor, water is not only an indispensable ingredient for human life, seen by many as a right, but also indisputably an economic and social good unlike any other. It is a commodity in its own right… but it is also a crucial connector between humans, our environment and all aspects of our economic system. (World Economic Forum 2011: 3)

It argues that water places the only natural limit to economic growth. For example, it is '*the single constraint to expanding cities*' (World Economic Forum 2011: xxi). One of several explanations that the World Economic Forum gives for claims of growing water scarcity and its risk to economic growth, is the under-pricing of water as a resource. This, for example, has led to some regional 'bubbles' of agricultural prosperity, that in the long term are not sustainable, as water resources become depleted beyond the rate of replenishment. The report also argues that a weak international trade regime, and a complex arrangement of tariffs and subsidies, amplify the cost of food shortage (ibid 2011). In an earlier report, the World Economic Forum had referred to the burst bubble phenomenon as the concern that underpinned this nexus with the idea that, with resource scarcity and water insecurity,

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[4] The 'Water Energy and Food Security Nexus – Solutions for the Green Economy' conference was held in Bonn, Germany in November 2011. It was organized by the German Federal Government in partnership with the International Food Policy Research Institute (IFPRI), the World Economic Forum and the World Wide Fund for Nature (WWF) as a 'specific German contribution to the UN Conference on Sustainable Development' "Rio2012"' http://www.water-energy-food.org/en/conference.html (6 March 2014)

[5] The 2014 World Water Week, to be held from 31 August to 5 September 2014, adopts the theme 'Energy and Water' http://www.worldwaterweek.org/ (8 April 2014)

[6] Nexus has been discussed before in academic circles, in particular amongst those researching water resources. Peter Gleick (1994), for example, wrote about the nexus between energy and freshwater arguing that there are strong interconnections between the growing water crises and conflicts over energy resources, and that they should be considered together for policy and decision making.

a business-as-usual approach will burst the bubble of productivity and economic growth (World Economic Forum 2009a).

The World Economic Forum approach to the nexus stresses the business imperative and the need to prepare for investment scenarios in the near future. It underlines that the economics of water is both compelling and challenging and that water security, economic development and Gross Domestic Product (GDP) are interlinked (World Economic Forum 2009a). It thus argues for recognition that future global investments will be significantly driven by the consideration of water, and will become a mainstream theme for investors. Global financial regulators, therefore, will have to develop clear-cut rules to manage the flow of innovative water funds.

Others, however, have highlighted that limits on economic growth due to water is place specific and may not be the general case (Barbier 2004). Brown and Lall (2006) suggest that it is rainfall variability, in particular, that is a significant factor shaping economic growth, rather than a generalized water scarcity. Furthermore, from the perspective of social justice, water scarcity may be constructed by inequitable allocation and access, rather than an absolute shortage of water *per se* (Mehta 2010). This raises the question of who can access water resources, and who is excluded and how?

The World Economic Forum perspective has ushered in a new brand of resource realism (Wales and Winston 2012). It has provoked new public-private collaborations between International Financial Institutions (IFIs) and large transnational corporations such as Coca Cola, Nestlé and SABMiller who want to harness the private sector's 'comprehensive value-chain viewpoint' to tackle nexus governance and also advise governments, other corporates and communities in nexus governance (Wales and Winston 2012). It therefore stressed four follow up measures (World Economic Forum 2011):

1. A task force for data collection;
2. A major program of economic modeling of interdependencies;
3. New models for collaborations to help Governments make policy changes;
4. Re-imagining institutions to improve governance.

The business logic is as follows: to grow, economies should shift their water allocations away from farming and toward uses that deliver higher economic value per litre, especially energy production, industry and manufacturing. Within this logic, governments will therefore have to make choices about the allocation of water between sectors, and, of course, are encouraged to pursue high value water uses. At the same time these shifts mean that they become more reliant on water use-efficient agriculture alongside food imports. To respond, the world system will need more trade flows in agriculture across more countries (World Economic Forum 2011).

Since the World Economic Forum of 2008, the nexus argument has proliferated in a range of high-profile global negotiations, in particular the Rio+20, and the language of the nexus has been used to articulate the resource scarcity that the world is to face in the coming decades. In a seemingly odd turn, in earlier decades, the Club of Rome's language of limits and scarcities –which was used mostly by environmental activists – was dismissed by rugged market individualism with the counter-argument that there were always substitutions available or waiting to be invented (see Robbins *et al.* 2010: 11-45). This time around, however, it is leaders of business who are using the language of scarcity alarmism to goad governments into (their) desired course of action.

The Nexus approach gained momentum as it also became strongly linked to the emerging idea of the 'green economy', which was the United Nations Environment Program's flagship concept put to the

Rio+20 conference. The green economy clearly constitutes a major new paradigm discussed both in the context of Rio+20 and the proposed post-2015 'Sustainable Development Goals.' As Hoff puts it:

> The Green Economy, an economy that results in improved human wellbeing and social equity, while significantly reducing environmental risks and ecological scarcities [.. .]. In Green Economy natural capital is valued as a critical economic asset as a provider for benefits for the poor [...] it is the nexus approach par excellence.
> (Hoff 2011: 6)

Of course, the green economy refers to a range of ideas including that of 'clean energy' and other ecological modernisation concepts, although so-called clean energy options raise other complex socio-environmental issues, in terms of energy use. For example, the rising production of biofuel crops have been linked to deforestation and competing uses of land with agriculture, including small-holder agriculture (Borras *et al.* 2010). The Green Economy also clearly pushes for a commodification of natural resources, which provides for some a way to deal with resource scarcity linked to the nexus by putting a price on natural resources. Not all endorse the concept of Green Economy. The World Social Forum has called it 'the Green Washington Consensus', stating, 'This latest phase of capitalist expansion seeks to exploit and profit by putting a price value on the essential life-giving capacities of nature.' (Working Group on Green Economy 2012).

The German Federal Government, which hosted the Bonn 2011 conference on the nexus, has been a key actor, pushing the nexus approach at global policy level. As put by the German Federal Ministry for Environment Nature Conservation and Nuclear Safety and Federal Ministry for Economic Cooperation and Development in their paper presented at the Bonn Conference (German Federal Ministry for Environment Nature Conservation and Nuclear Safety and Federal Ministry for Economic Cooperation and Development 2011), this new approach identifies mutually beneficial responses and provides an informed and transparent framework for determining trade-offs and synergies that meet demand without compromising sustainability. The Bonn paper underlined this competition over resources against the backdrop of urbanization, growing population and increasing levels of consumption, globalization facilitating trade and investment, and resource degradation, and amplified through climate change (ibid 2011; see also Bogardi *et al*. 2012). The nexus sectors, food, energy and water, are thus understood to be interdependent and in need of integration (Hoff 2011). Three guiding principles are proposed: investing to sustain ecosystem services; creating more with less; and accelerating access, integrating the poorest (Hoff 2011).

'Nexus' thinking becomes a shorthand for this confluence of trends and the need for explicit trade-offs in policy-making (Dupar and Oates 2012). The dominant approach to this 'nexus' thinking is through socio-ecological systems, analytical frameworks that seek to understand trade-offs and synergies, increase efficiency, and improve governance between food, water and energy systems (e.g. Hoff 2011; Smajgl and Ward 2013). The nexus thus seeks to integrate sectors through making them visible and thereby aims to address externalities that link sectors together. It raises a need to openly discuss trade-offs and the decisions that this entails. The governance of these decisions, namely who takes decisions and for whom, is also important yet has been less rigorously discussed to date. Furthermore, given that food, water and energy sectors often exist in silos, integration may be challenging to put into practice. That water, land and energy have different governing regimes will make nexus governance even more difficult.

Bazilian *et al.* (2011) reveal the complexity of this interconnectedness in identifying both analytical and policy making entry points:

> If a water perspective is adopted, then food and energy systems are users of the resource (see e.g.,Hellegers and Zilberman 2008); from a food perspective energy and water are inputs (see

> e.g., Mushtaq et al., 2009; UN-DESA, 2011; Khan and Hanjra, 2009); from an energy perspective, water as well as bio-resources (e.g., biomass in form of energy crops) are generally an input or resource requirement and food is generally the output. Food and water supply as well as wastewater treatment require significant amounts of energy. Of course, areas such as food-as-fuels (i.e., biofuels) tend to blur these descriptions…
> (Bazilian et al. 2011)

Dupar and Oates (2012) warn that nexus thinking, in its simplistic form, might lead to the commodification of resources most readily or profitably monetised (perhaps for short-term gain), underplaying other long-term environmental externalities, such as biodiversity protection, pollution or climate change. They argue for a nexus approach, which is sensitive to political economy issues, including open, inclusive and transparent negotiation and rights-based approaches. Meanwhile, socio-ecological systems analytical framework approaches have been critiqued as under-theorized or under-politicised, in particular with regard to historical and relational considerations. Foran (2013) has argued for linking system frameworks that identify significant nodes of interaction with political ecology frameworks that provide insight into the social regimes that govern those nodes.

For many, water security remains central to the concept of nexus especially in the sense that it is mostly the international water policy sector which has taken up the language of the nexus (compared to those focusing on energy and food).[7] Though water and energy are closely linked in the production phase, water security *is* prioritised in the nexus debates; in short, food and energy security can only be achieved through water security. Climate change appears at a relative periphery of this debate, it is an amplifier but not the primary driver for change.

The presentation of hard statistics about water consumption in food and energy and the proposal for nexus approaches, may give a veneer of newness to global policy makers, and yet looking in more detail at the discourse of the nexus to date, there is far less clarity on what a new common integrative approach might look like, beyond the existing water-centric paradigm of Integrated Water Resources Management (IWRM). This begs the question whether 'nexus' is merely a new development buzz word (Dupar and Oates 2012) and what, to date, is new about nexus that did not exist in earlier resource management knowledge?

One way to answer this question is to focus on a particular policy issue linked to the nexus: the argument for having more large dams and storage devices, as a way of ensuring water security and managing the trade-offs between water, energy and food, while at the same time addressing the imperatives of dealing with climate change for clean energy. (Hoff *et al.* 2012). Sean Cleary, in the World Economic Forum's Report, highlights the vicious circle of energy, water and climate change, arguing that: 'we need more energy for more development but the current processes of energy production put pressure on water availability which has an impact on climate; climate change variability affects water availability patterns and that, in turn, affects energy production.' (World Economic Forum 2009b).

For those more centrally concerned with climate change, water storage from large dams kill two birds (water-food-energy as well as climate change impacts) with one simple 'nexus' stone. Lall (World Economic Forum 2011) argues that in the backdrop of climate change and climate variability, the key question that global society faces is, 'how should our water best be stored and which stores should be used to minimize risks due to long term climate variability and change? Storage guarantees reliability in water supply, which in turn means food security, electricity generation and industrial growth.' Lack

[7] Depending on the perspective on the nexus – i.e. some see the nexus as an approach to interrogate the relationship between food, energy and water – adopting a systems approach. In this frame, water *security* although implicit, may not be problematized (see below).

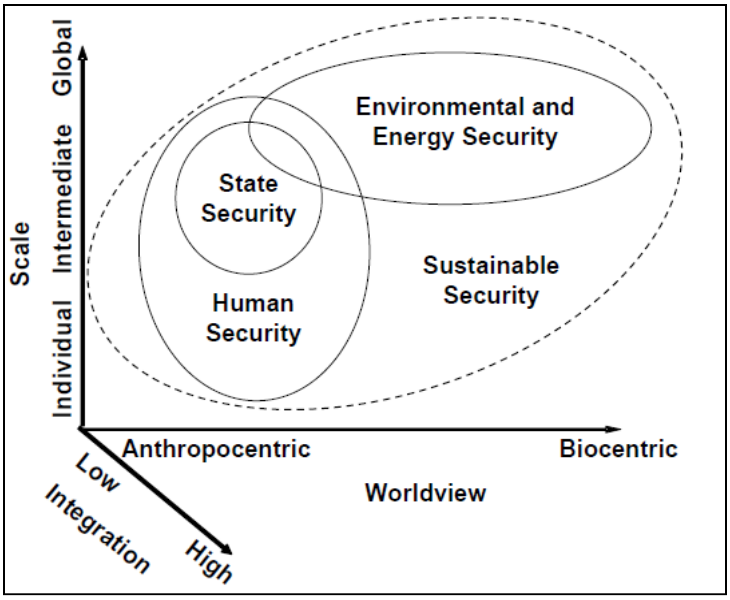
of water storage infrastructure is predicted by some as a serious impediment to economic growth in developing countries (Grey and Sadoff 2007). Climate change also has implications for existing infrastructure, i.e. dams designed in the past without accounting for the increasing variability of climate change are now increasingly at risk (i.e. 100 year floods may be more severe, meaning that infrastructure is under-designed).

4. When Security Meets Sustainability: A Static Nexus?

The emergence of the nexus is argued above to have emerged from concerns over scarcity and sustainability. Furthermore, the nexus has gained momentum at the expense of IWRM which has according to Bird (2012), 'tended to stay within the domains of the water, agriculture and environment professionals and not had much traction with energy sector professionals.' Dore *et al.* (2012) also argue that it is unlikely the rhetorical (and financial) turn to Water-Energy-Food would have been so swift without the late 2009 failure of the United Nations Climate Change Conference in Copenhagen. In our view, the nexus is also emerging from the convergence between human and state security concerns around access and availability of resources and sustainability, articulated in particular around green economy and business concerns. Inter-connected issues like poverty, food security, economy, energy security and other environmental issues have emerged as new kinds of security threats (Voigt, 2009; Khagram *et al*. 2003). Security, similar to the concept of scarcity, 'is a relational concept' (Mehta 2007 cited in Beck *et al*. 2013). The two concepts, scarcity and security, are often inter-linked; indeed, as Beck *et al.* (2013) emphasise, even as much of the notion of water security builds from a presumed scarcity, 'scarcity-security is a strong bond. But scarcity is not the only factor determining security.'

The scale and degree of integration of various securities and worldviews (anthropocentric and biocentric) (see Figure 4.1 below) are fundamentally changing the convergence between sustainability and security that goes beyond the environmental security debates of the 1990s and the environmental peacebuilding debates of the 2000s. Climate change is becoming the driving force behind these debates and is seen as one of the major threats to global, national and human security (Barnett 2003). For instance, some studies suggest that climate change will increase the intensity of extreme weather conditions and has the potential to cause mass migration, create food and water insecurity, and cause several other environmental and social impacts (Voigt 2009; Khagram *et al*. 2003).

Figure 4.1: The four paradigms of security according to scale, degree of integration of various securities, and worldview (Levy, 2009)



States' pre-occupation with traditional security, whilst remaining important, has been supplemented by considerations of non-traditional security, including food, water, energy, and climate security. For instance, the United Kingdom's 2010 National Security Strategy (NSS) acknowledges that climate change poses a security threat because it will increase the frequency and severity of extreme hazards, put pressure on international institutions (including defence), increase pressure on food, water and energy supply, increase incidence of diseases, and also lead to increases in cross-border movements that could give rise to disputes (HM Government 2010). Missing in all of these preoccupations is the issue of security sought by households in the South, many of whom exist within the vast informal economy, through which they survive and cope with external circumstances. Those in the informal economy have sought their security through decisions regarding outmigration and participation in what is called the 'remittance economy', whether nationally or internationally.[8]

While states have focused on climate security as a key priority, business and UN specialised organisations have also, as we have seen in the previous section, emphasised security concerns, linked to access to water, food and energy. PricewaterhouseCoopers (PwC), for example, published a report in 2011 showing that over 60 percent of the CEOs in Asia think that water security is critical to free trade (PricewaterhouseCoopers 2011). So, as water security concerns grow, so too does the pressure for new policy solutions (Jung 2012).

Historically security has been concerned with safety and therefore can be understood as the condition of being protected from, or not exposed to, danger. This arguably tends towards stability thinking, where a belief prevails that change can be controlled rather than necessitating adaptation to circumstances that are beyond control. For example, until now, powerful hydrocracies[9] have tended to view water and ecosystems as static systems, which in turn shapes an illusory view of food, water and energy security as static too. All actors, including new and old civil societies and social movements, the private sector, IFIs, International Organisations and academics all understand and frame sustainability and security differently (see Box 4.1 below).

Some authors have articulated the concept of 'sustainable security' as one based on a preventive approach, which focuses on interconnected and long-term drivers of insecurity that include climate change, competition over resources, marginalisation of the majority world and global militarization (Voigt 2009). Going beyond traditional human security concerns linked to poverty reduction and ecological stress, the concept also embraces new forms of collective security and prevention, in line with planetary boundaries debates favouring the introduction of early warning systems, in relation to some boundaries' threshold. The concept of 'sustainable security' acknowledges the relationships between environment, development and security. It blends notions of national security, collective security, and human security into a preventative approach to short and long-term threats (Parsons 2011). Similar views are also expressed by Khagram *et al.* (2003), who state that sustainable security integrates state, human and environmental security.

The concept has gained momentum following six regional Ford-Foundation consultation meetings, in which the Oxford Research Group (ORG) laid the foundations of the 'sustainable security' approach. Other groups such as Quaker Peace and Social Witness, The Fund for Peace, and the Center for American Progress have been promoting or discussing the concept.

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[8] See Gyawali (1997) and Desakota Study Team (DST) (2008). The informal economy has remained a traditional blindspot in developmental thinking and programs and therefore has failed to anticipate the global surge in economic migrations and the remittance economy that ensues either nationally or globally. A 'toad's eye' perspective via the informal economy (as opposed to the 'eagle eye' perspective of national governments and international development agencies) would present a very different picture of 'security' or 'sustainability' where traditional planning and developmental categories such as 'rural' and 'urban' are becoming increasingly fuzzy.

[9] Hydrocracies are large, powerful state-led water resources development agencies, staffed predominantly by engineering professionals, that pursue "hydraulic missions" of modernization through large-scale infrastructure projects – namely hydropower development and irrigation schemes – to harness and control a country's water resources (Molle *et al.* 2009).

Box 4.1: Framing Security

Framing Security

There is a growing literature on the linkages between natural resources, sustainability, and security. Brauch (2011:62), in posing the question, '[security] for whom, by whom and from whom, security of what and for what?', invites us to explore the range of possible forms of security in a more nuanced analysis. There are multiple documented definitions of water, food and energy security. Clearly, different actors understand and frame security differently. Whether thinking on security is static or dynamic depends on whether the inevitability of change is acknowledged and integrated into planning and governance.

Water security has been understood in multiple ways including (see also, Allouche et al 2011):

- '[Water Security is] the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economics.' (Grey and Sadoff 2007)
- Water security, linked to state security, to avoid 'water wars.' (Gleick 1993)
- Water security as competition over uses between competing sectoral demands
- Water security as (right to) individual access to water (freedom from fear, freedom from want, freedom to live with dignity) (Gutierrez 1999)

Likewise, food security has been juxtaposed against the concept of food sovereignty as follows:

- The World Food Summit of 1996 defined food security as existing, 'when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life.' (FAO 1996)
- Food Sovereignty has been both defined and put into action in multiple ways (Patel 2009), with the basic concept captured by Via Campasina in 1996 as, 'Food sovereignty is the right of each nation to maintain and develop its own capacity to produce its basic foods respecting cultural and productive diversity.' The concept continues to be hotly contested and debated.

Finally, with regard to energy security, the focus is often on the diversity of potential priorities for ensuring energy security, for example between urban versus rural areas, and household versus industrial buyers. Hoff (2011) defines energy security as, ' access to clean, reliable and affordable energy services for cooking and heating, lighting, communications and productive uses; uninterrupted physical availability of energy at a price which is affordable, while respecting environmental concerns'. Meanwhile, Hildyard *et al.* (2012) highlight that attaining 'national energy security' is typically interpreted as energy to ensure economic growth, which is not necessarily equivalent to 'energy for all' that prioritizes energy to meet basic needs. They write:

> Like many other political buzzwords, 'energy security' has become a plastic phrase used by a range of different interest groups to signify many often contradictory goals. For many individuals, energy security may simply mean being able to afford heating in the depths of a cold winter or having access to a means of cooking – a 'logic of subsistence'. For political parties in government, it may mean ensuring that a nation' s most important corporations have reliable contracts with guaranteed fuel suppliers until the next election. For exporting countries, it may mean making certain that their customers maintain their demand for their oil or gas via long-term contracts…
> (Hildyard *et al.* 2012)

Hildyard et al (2012) highlight the way the words "energy security" are often used to justify energy enclosures, whilst masking energy inequalities, creating new scarcities and insecurities as people are dispossessed of energy, food, water, land and other necessities of life.

Another type of literature on resilience and security argues the need to shift our attention from stresses to shocks. In the words of Alex Evans shocks, rather than stresses, are the primary triggers of change, as three global crises – the September 11 attacks in 2001, the combined food and oil price spike that peaked in 2008, and the global financial crisis in the same year – have demonstrated over the last decade (Evans, *et al*, 2010). In the 2011 World Development Report, the idea of resilience is taking grounds in the conflict and security world (World Development Report 2011).

Both types of literature (sustainability and security; resilience and security) rely on the same assumptions, that of the growing inter-linkages between natural resources and different forms of securities. They also reinforce the existing emerging discourse on biosphere security (Voigt 2009), which highlight potential dangers from the perspective of the earth as a global system. As a solution, both literatures rely on the premises of a preventive and integrated approach, including preventive, through early warning systems (e.g. the idea of a national security index of indicators and thresholds for natural resources, see Parthermore 2010), and integrated, in the form of inter-agency collaboration (e.g. collaboration between the National Oceanic and Atmospheric Administration and USAID on national security in the US). Voigt (2009), meanwhile, believes that 'sustainable security' should be based on three broad aspects, cooperation, precaution and prevention of conflicts, and holistic assessment and monitoring. These three aspects are very much in line with the nexus agenda as discussed above.

Conceptually, the Nexus and the different associated securities in terms of water, food and energy present some complex challenges in terms of sustainability. While we recognize the key dynamics driving these processes, we contend that the literature on sustainability and security and resilience and security tend to see ecological change and transformation as threats. Both approaches share common tendencies towards the idea of stability, to bring the 'situation under control' with expressions such as 'halting' or 'curbing' climate change. There is an illusion that this 'stability' might be achieved through manipulating a few variables, out of the millions of interlinked and dynamic factors, which govern the world's climate. As expressed by Philip Stott already in relation to ecological systems:

> Our ecological language is suffused with a desire for 'stability' and 'safety' (the so-called 'precautionary principles'), whereas in reality all is Heracleitan flux, and we can never 'step into the same river twice.' We are trying to replace human flexibility and adaptation by god-like control and statis, and it will not work.
> (Stott 1998)

5. Synthesizing security, sustainability and the nexus: Towards a methodology

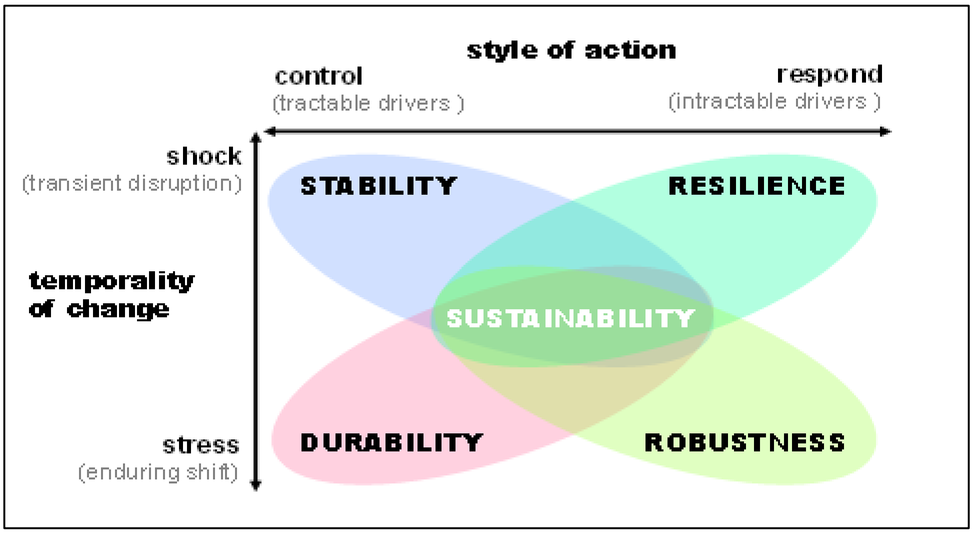
Our conceptual framework is built on the assumption that discourses over non-traditional forms of securities are affecting ways of policy framing of long term sustainability in the area of water, energy and food. The convergence between security and sustainability raises notions of equilibrium thinking as summarized by the idea of balancing (balance of power, balance of nature).

However, Leach *et al.* (2010) show how recent understanding of ecological systems has shifted from seeing nature as 'in balance' to recognizing ecological systems as being in a dynamic non-equilibrium with potentially non-linear responses and multiple stable states. This dynamism becomes more complex as ecological, social, economic, technological, and political systems interact. The hydrological cycle, for example, is a highly dynamic system, ecologically, socially, and technologically (Mehta *et al*. 2007), and will become *even more* dynamic under the conditions of climate change.

Narratives prioritise different aspects of systems dynamics (see figure 5.1) and propose different strategies to deal with them.

- **Stability:** if a system is assumed to move along an unchanging path, the strategy may be designed to exercise control
- **Resilience:** if limits to control are acknowledged, the strategy might be to resist shocks in a more responsive way
- **Durability:** if a system may be subject to stresses and shifts over time, interventions may attempt to control the potential changes
- **Robustness**: strategies that embrace both the limits to control and an openness to enduring shifts

Figure 5.1: Dynamic Properties of Sustainability (Leach et al. 2010: 62)



Leach *et al.* (2010) argue that often 'static' thinking (big, technically driven, managerial solutions that seek to control variability) rather than 'dynamic' thinking (adaptive, reflexive thinking and "clumsy" solutions that accommodate and respond to change) prevails, resulting in failed outcomes for projects and policies. Existing managerial approaches have a tendency towards 'stability' solutions, which may not be appropriate for dynamic systems. From this perspective, it would appear that present dominant solutions are framed according to stability and durability, excluding resilience or robustness.

Conceptually, our ongoing research project aims to introduce non-equilibrium thinking to non-traditional forms of securities, i.e. human security (human rights framework – normative element) and regional/global security. This requires a different mindset in comprehending and conceptualising security, not seeing security as a fixed objective but as a concept that accepts changes and non-equilibrium. It requires a transition from analytical assumptions of equilibrium thinking, centered on linearity, predictability, homogeneity and simplification to ones that encompass non-linearity, complexity, uncertainty, ambiguity, and surprise (Leach *et al*. 2010).

In this respect, both cultural and ecological theories may help to sharpen our understanding of dynamic security by integrating and accepting inevitability of change in planning. Kurtz and Snowden (2003) draw a distinction between complicated systems that are more amenable to attempts to engineer stability and durability, vis *à vis* complex systems that are in disequilibrium, embody elements of surprise and to which resilience and robustness responses are more appropriate. Meanwhile, the Theory of Plural Rationalities (also known as Cultural Theory) argues with its 'theory of surprise' that different ways of organising are based on different ways of understanding how the world is and how it is supposed to work.[10] When the world, both the physical as well as the social that exploits the physical in different ways, happens to behave in a way not anticipated by the particular way of organizing (but advocated to do so by other ways of organizing opposed to that particular way) there is surprise and re-adjustment both of worldview and behaviour. Thus *surprise,* the outcome of the ever-widening discrepancy between the expected and the actual, is of central importance in dislodging people from their ways of organising and helps us towards a 'theory of change' that makes change permanent and intrinsically forever in dynamic flux (Thompson 2008). As argued by Gujit:

> The predominantly positivist and 'development-as-project' vision that guides such monitoring is inconsistent with the emergent and non-linear nature of institutional change that occurs through 'messy' partnerships and that is increasingly central in rural development and resource management. It is also inconsistent with the everyday reality of monitoring as a continual informal dialogue among development actors, not bound by official monitoring procedures and protocols.
> Gujit (2008: 287)

In our ongoing project to which this Working Paper contributes we intend to explore the extent to which the concept of security may be extended to include change and non-equilibrium, given that 'security' in a general sense is the condition of being protected from, or not exposed to, danger and has historically been concerned with safety and certainty from contingency (Dower 1995). From the perspective of the STEPS Centre and its project methodologies, it is yet to engage clearly with the concept of 'security.[11] We hypothesise that the convergence between security and sustainability is governed by stability and equilibrium thinking that creates particular pathways. The project in this respect will identify the diverse narratives of 'security' and the purposes they serve (see Box4.1 above), in particular with regard to discourse around the nexus. We intend that our approach will

[10] Cultural Theory's four ways of organising (four social solidarities) are: bureaucratic hierarchism, market individualism, activist egalitarianism and the fatalism of non-galvanized masses, the voters or consumers. The worldview of each way of organizing is only partly right and never wholly wrong but has to constantly be in battle with other ways of organising as the world keeps dishing out the unexpected surprises. See Thompson *et al.* 1999.

[11] See 'pathways methods' http://steps-centre.org/methods/pathways-methods/ (8 March 2014)

contribute to the acknowledgment of the value of plural ways of understanding problems and solutions around food, water and energy nexus.

In turn, we aim to contribute to the broader understanding of how concepts of sustainability and security limit current options to think about water storage and hydrological uncertainty, where typically static man-made systems are believed to be more secure. Following a pathways approach,[12] we will seek to broaden out the inputs to planning processes and appraisal methods, and 'open up the outputs' to decision-making and policy to recognize the different pathways to sustainability around the nexus.[13] Responding to the emerging global discourse of the food-water-energy nexus with a re-conceptualisation of the nexus with a critical analysis of food-water-energy security and sustainability, we hope that alternative pathways are opened with impacts on the ground. To this end, our project focuses on case studies in South and Southeast Asia.

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[12] Development pathways, defined as 'the particular directions in which interacting social, technological and environmental systems co-evolve over time' (Leach *et al*. 2010:xiv), can be either sustainable or unsustainable. Pathways are historically contingent and often become 'locked-in' for many reasons, including past decisions and sunk investment, alongside technological, social and political inflexibility. The pathways approach has been applied to a range of issues including: climate change; energy; pandemic disease; water scarcity; hunger; poverty; and inequality.

[13] 'Broadening out inputs' to planning processes and appraisal methods includes: participatory engagement; extended scope to include multiple criteria and scales; an acceptance of a diversity of knowledges; the need to acknowledge uncertainty; and the importance of addressing issues of rights, equity and power. 'Opening up the outputs' to decision-making and policy includes: giving serious consideration to a range of options and possible alternatives; and a move towards more adaptive, deliberative and reflexive forms of governance and political engagement (Leach *et al*. 2010: 100).

6. A Static Nexus? Water storage and Plural Solutions

In addressing water scarcity, ensuring water security and its associated nexus, as well as climate security,[14] it is often the case that the perceived need for more water storage is interpreted as the need to build more large dams. This in turn has fuelled the cause of more large dams in development. The idea of storage has remained central to the demand of development and large dams have been the central focus of storage for the last century (McCartney and Smakhtin 2010). Many developing country nations resorted to dam building, especially in their early years of postcolonial history. The aim was to build dams, especially of the multipurpose nature, that could cater to the demands of hydroelectricity and agriculture. Dams at the same time became synonymous and symbolic to the nationalist discourse of development (Allouche 2005). The International Commission on Large Dams (ICOLD, 2003) states that 50 percent of the 50,000 dams constructed globally have been built to support irrigation, whilst the remainder have been built for hydropower, and industrial and commercial water supply. Countries in arid and semi-arid regions have built dams with large storage capacities to match water demand and security of supply, and security of risk against drought (World Commission on Dams 2000).

The emphasis on the centrality of water storage for ensuring water security within the nexus discourse to date has given a boost to the large dam construction industry. Indeed, it has been since 2003, following a relative hiatus from large dams, that the World Bank has (re)argued that investment in large water infrastructure is necessary to unlock economic growth (Calderon and Serven 2004). This has also lent support to the construction of dams in developing countries (McCartney and Smakhtin 2010). The World Bank has argued that measures have been developed to mitigate the social and environmental impacts of these projects, yet in practice it is difficult to decouple the negative consequences of building large water infrastructures. In January 2014 the World Bank launched its 'Thirsty Energy' initiative that argues, 'the world's energy systems are inextricably linked with water systems', and, 'with demand rising for both resources, water scarcity can threaten the long-term viability of energy projects and hinder development.[15]

Globally, however, large dams have proved controversial. The World Commission on Dams (WCD) concluded that whilst:

> 'Dams have made an important and significant contribution to human development, and the benefits derived from them have been considerable […] In too many cases an unacceptable and often unnecessary price has been paid to secure those benefits, especially in social and environmental terms, by people displaced, by communities downstream, by taxpayers and by the natural environment.'
> WCD (2000)

In a review of where the debate stood ten years after the 2000 WCD Report, a special issue of Water Alternatives concludes the need to re-visit the controversy in the following words, 'Why revisit the World Commission on Dams? The answer, in one simple phrase: because the issues of contention around dams have not gone away!' (Moore *et al.* 2010: 3). Furthermore, while hydropower is celebrated as a clean and renewable source of energy (World Bank 2009), the harnessing of this

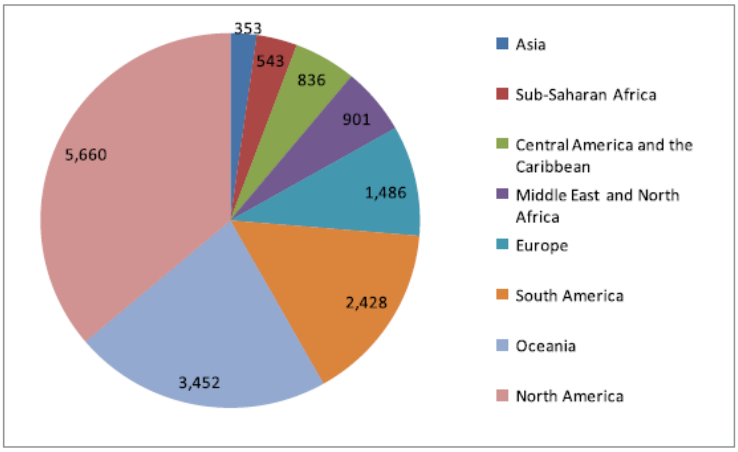
[14] In the light of climate change debate, enhancing storage capacity to address issues of intermittent rainfall that exacerbate food insecurity, poverty and vulnerability, is one of the important mitigation and adaptation strategies.

[15] http://www.worldbank.org/en/news/feature/2014/01/16/will-water-constrain-our-energy-future (8 March 2014)

potential critically depends on the availability of water.[16] Therefore water storage is a necessary condition for the development of large-scale hydropower. However, climate change variability may have cascading effects on hydropower generation limiting its potential during variable climate occurrences as floods and droughts.

Figure 6.1 below provides a cross-section of per-capita storage in the world in relation to man-made infrastructure.

Figure 6.1: Per capita water storage (in cubic meters (m^3)) in human-made reservoirs by continent (McCartney and Smakhtin 2010)



Source: White 2005

Note: In Africa the lack of storage arises because relatively few (less than 2,000) large dams have been constructed. In contrast, in Asia many large dams have been built (about 18,000), particularly in China, but the high population means that per capita storage is low.

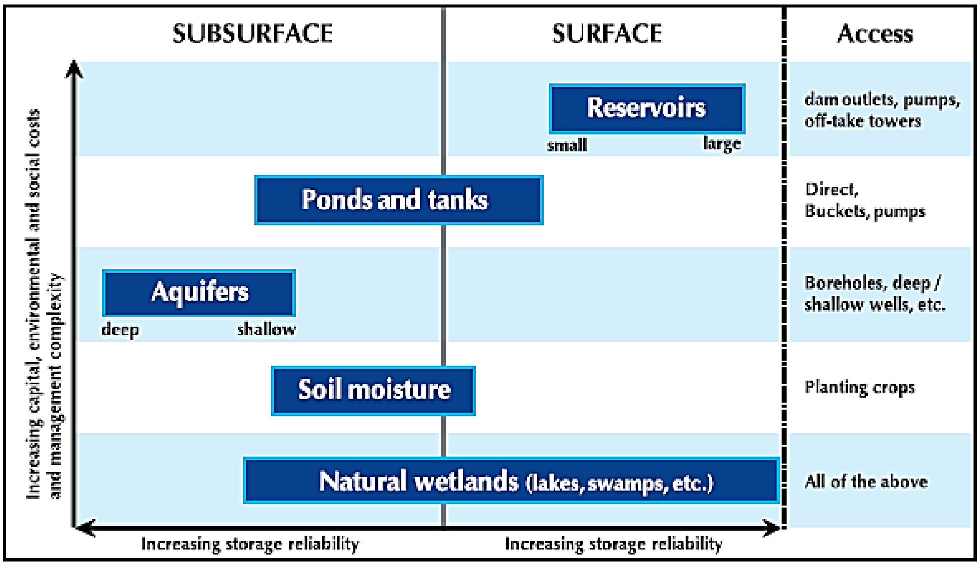
McCartney and Smakhtin (2010) point out that a range, or a '*continuum*', of water storage options exist that include: natural wetlands; enhanced soil moisture; groundwater aquifers; ponds and tanks; and large or small dams/reservoirs (see figure 6.2). Whilst not all storage types fit all purposes, they argue that, 'Each has an important role to play and, under the right circumstances, can contribute to food security and poverty reduction.' Various studies demonstrate the contribution that small-scale technologies can play in ensuring water security, in particular for smallholder farmers (FAO 2008, Hagos *et al*. 2012, McCully 2006, Wisser *et al*. 2010). McCartney and Smakhtin (2010) propose that 'All [water storage options] have strengths and weaknesses which depend, in part, on the inherent characteristics of the storage but are also affected by site-specific conditions and the way the storage is planned and managed. Consequently, each storage type needs to be considered carefully within the context of its geographic, cultural and political location.'

At present, however, not all water storage options are considered equally within planning and assessment processes. Indeed, McCartney and Smakhtin (2010) suggest that with the exception of large dams, which are typically conceived and led by the state and large business, the development of alternative storage options has, at best, been largely ad-hoc in nature and left to local communities,

[16] Hydropower has been argued to be a clean energy mechanism as compared to fossil fuel based thermal generation of electricity. Except for reservoir evaporation, it is a non-consumptive use of water. It is considered to have low operating costs and a long life in relation to infrastructure creation and use (World Commission on Dams 2000). However others have pointed to the environmental and social costs of hydropower, including changes to hydrology, wild capture fisheries, and ecological impacts. Conflicts can also arise between hydropower and downstream uses, including irrigation, in-stream uses, and supporting ecosystems. Furthermore, there is a growing body of evidence that hydropower dams can emit large amounts of methane gas, a potent greenhouse gas.

NGOs or local businesses, or totally ignored by national planners. Alternative storage options are therefore developed with limited planning, for example, in relation to other nearby water uses and management arrangements. At a minimum, this lack of coordination may result in sub-optimal gain of benefits whilst, at worst, outcomes may negatively affect people's well-being and give rise to local conflicts. Furthermore, some storage options are not readily recognised by international organisations and planners. For example, in India farmers in drought-vulnerable regions grow water intensive crops during years of water abundance that can be stored for several years, thus transferring embodied water within the crop to years of drought.

Figure 6.2: Conceptualization of the physical water storage continuum (Reproduced from McCartney and Smakhtin 2010)



McCartney and Smakhtin (2010) propose that for water storage to be more reliable and resilient, and to allow for greater uncertainty in the context of climate change, 'storage 'systems' [i.e. a mix of storage types] that combine and build on complementarities of different storage types are likely to be more effective.' Indeed, as we argue further below, pursuing plural pathways to accommodate complexity and (climate) uncertainty would also require a rebalancing in governance from 'stability and durability thinking' that tends towards control approaches and the construction of (large) man-made structures and towards incorporating 'resilience and robustness thinking' where the limits to control are acknowledged and adaptive solutions that incorporate plural solutions are pursued. In light of myriad physical uncertainties and social vulnerabilities that different societies in varied ecosystems have to cope with, what 'robustness' would mean is not one perfectly optimised, large-scale solution but what has been called 'many ten percent solutions' (NCVST 2009) amenable to action by different social solidarities.

Drawing on Cultural Theory, these plural solutions might be considered as 'clumsy solutions' that benefit from the deliberate interaction of multiple worldviews on perceptions of problems and associated risk, ways of organising social relations, and ultimately generating creative, new solutions and alternatives and plural policy responses (Verweij *et al*, 2006, Gyawali 2009). Indeed, complex food-water-energy nexus problems are so-called 'wicked' problems with no easy definition nor easy solution (Rittel and Webber 1973, Lach *et al*. 2005). Dynamic sustainability approaches and plural, clumsy solutions, given their reflexive and interdisciplinary perspectives, are particularly apt to be applied to such challenges. Furthermore, plural solutions to water and food and energy challenges offer the potential of better outcomes in terms of both effectiveness and social justice outcome. In our project, we intend to draw these links out more clearly.

7. Conclusion: Towards a dynamic approach to security and sustainability in the water-energy-food nexus

The water-energy-food nexus is emerging globally as a research agenda and governance framework for understanding the relationship between water resources development and the energy and food sectors. Water storage is usually seen as a solution to hydrological uncertainty and water and climate (in)security, and therefore is also considered integral to the water-energy-food nexus.

The unabashedly audacious aim of our project is to turn the nexus and storage logic upside-down. While large water storage infrastructure is usually seen as both a solution to water-climate security and hydrological uncertainty, and the water-led energy and food security nexus, we will start with the proposed solution and see how it contributes to these securities. By starting with the desired/logical solution, we will seek to understand how alternative pathways around storage and their use in terms of energy and food have been dismissed. Our analysis will examine how mainstream pathways have been legitimised (or not) in planning processes and the use of assessment tools through notions of water (or food or energy) security, followed by an assessment of how secure these securities really are. We aim to make the alternatives that exist, which are often practiced even as they are marginalised, more visible. By taking a systemic and dynamic perspective on storage we intend to provide clues as to how alternative pathways to sustainability and social justice can be pursued. We do this with a view to better capitalise on and broaden the current water-energy-food discourse.

Our project’s conceptual objectives are along four lines:

- Extend the dynamic sustainability framework through engaging with notions of various types of securities (traditional, non-traditional and human security…)
- Sharpen the dynamic sustainability framework through exploring how cultural theory/ clumsy solutions and sense-making might contribute to it
- Understand how different framing and preferred solutions have emerged and impacted on the dynamics of the water-energy-food policy process and the determined pathways to sustainability
- Contribute to the idea of dynamic systems through the example of a continuum of water storage and how these contribute towards water, food and energy security

In combining these four objectives, the project highlights the 3Ds approach (diversity, distribution and direction):

- Diversity: the need to move away from social and technological inflexibility indicators[17]
- Distribution: the need to recognise those excluded and marginalised from preferred solutions
- Direction: the need to recognise alternative pathways.

[17] One set of 'indicators of inflexibility' we play with is provided by Thompson (1994) building on Collingridge. His four indicators of technical inflexibility are: large scale, long lead time, capital intensity, and major infrastructure needs early on; and the four of social inflexibility are: 'single mission' outfits, closure to criticism, hype (as in 'if we do not cover the Himalayas with trees, Bangladesh will forever sink beneath the waves', and hubris (often in the form of over-confidence as to what the future holds, or categorical certainty that 'there is no alternative'.) They help in understanding different types of storage technologies.

The project is testing its aims by comparing a set of real world water storage case studies from Nepal-India and Thailand-Laos, two pairs of countries that each share transboundary rivers and that are increasingly tied together by jointly developed water resource development projects and cross-border power trade. We will drill down into the discourse and practices associated with the energy-water storage-security nexus in these regions (Table 7.1). We frame our analysis within the context of a new political economy of Asia and a new political economy of water, both built upon the foundations of the old political economies, that are imagining new visions for the future of Asia's major rivers.

Table 7.1: Objectives, Research Questions and Level of Analysis

Objectives	Research Questions	Level of analysis
1. The nexus and a dynamic approach to water, energy and food security	• Who is promoting the food-water-energy-climate nexus, how and why? • To what extent sustainability, resilience and security are understood as static systems? • How scarcity and crisis narratives are shaping the nexus?	Global
2. The nexus and non-nexus in South and South East Asia : the political economies and imaginaries of Asia major rivers	• What are the driving forces behind food and energy supply and demand affecting the new political economies of Asia's rivers? • Does the nexus have a meaning in the region? • What are the imaginaries and unplanned developments around the Asia's rivers' future?	Regional
3. Storage solutions versus Storage systems: (re)discovering plural clumsy solutions towards social justice	• How are storage options justified according to different understanding of food, energy, climate and water security? • How do assessment tools promote particular storage solutions? • What is the local understanding and practice around the relationship between food, energy and water (now known as 'the nexus')? • To what extent does storage systems in its different technologies addresses the trade-off/synergies within nexus? How to promote plural clumsy solutions?	2 pair of case studies Xayaburi and Rasi Salai in Laos-Thailand and West Seti and Kulekhani in Nepal-India

One of the assumptions of the project is that convergence between the ideas of security and sustainability tend to favour stability and durability solutions and do not incorporate resilience and robustness considerations. In this respect, storage is understood as a static solution, often reflecting the discourses, culture and ideology of technological-biased 'hydraulic mission' bureaucracies (see Footnote 9). Incorporating a dynamic perspective, Leach *et al.* (2010: 62) consider sustainability as, 'the maintenance of qualities of human well-being, social equity, and environmental integrity over time, and propose sustainable solutions such as, 'those that offer stability, durability, resilience, and robustness in specified qualities of human well-being, social equity, and environmental quality.'[18] In other words, plural water storage systems understood in the context of complex and uncertain relationships between food, water, energy and climate, that *combine* small and (where appropriate) large scale technologies must embody properties of stability, resilience, durability, and robustness to be sustainable (see Figures 5.1 and 6.2).

Though there is, broadly speaking, a policy trend to extend and expand on small projects and adopt watershed approaches, including unlocking storage capacity of soils and aquifers, the results have not displaced the preoccupation with water management primarily through the construction and operation of large storage dams. For many rural communities, however, food, water and energy has never been conceptually separated in the way that experts have sought to understand them. Indeed, it may be that the water-energy-food nexus is the (re)discovery by experts working in silos of what practicing farmers and fishers already know. Yet, if the nexus is to be a useful framework for exploring alternative pathways rather than a narrative that legitimises existing dominant pathways, the political economy of the nexus must be more explicitly addressed within the themes considered, and the concept re-conceptualised from top-down understandings of the nexus, to bottom-up ways of knowing the relationship between water, food and energy.

[18] Leach *et al.* (2010) furthermore emphasize that the goals of sustainable development are themselves context specific, represented through divergent frames, and are thus often contested between actors. Sustainable development, in other words, is both normative and political.

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